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⁎ *The above List is prepared from the Patent Records by Mr. T. Morgan, Secretary of the Inventors' Patentright Association, Limited.*

An improved thill coupling, recently patented by Mr. W. L. Wheeler, of Birmingham, Ill., is designed to admit of the thills or pole being readily detached when desired. To the axle is secured a thill clip, having lugs to receive the pin which fastens the irons of the thill or tongue. By means of a pivoted and slotted lever the pin may be easily withdrawn or locked into position by a key forming the outer end of the lever.

MENTAL LOGARITHMS.

By **Edw. David Hearn**, M.A., Columbia College, New York.

In his introduction to the "Complete and Immaculate Tables of Logarithms," published about half a century ago, Sir Richard Phillips remarked that "Logarithms are the most useful discovery ever made in the principles of arithmetic and calculation, and are so essential to operations in mathematics that in all education the facile use of logarithmic tables should invariably follow the study of decimal fractions." Since that time the teaching of logarithms has become so general that there is now scarcely a schoolboy to be found who is unable to employ logarithmic calculations to abbreviate otherwise tedious processes. To take a very simple example, let it be required to extract the cube root of 45·499593; and we have merely to take either the immaculate or any other reliable table, and turning to the natural number 45·5, which is quite near enough for all ordinary purposes, take out the logarithm, which is 658011, supply the characteristic which, as the integral part of the number, has two digits will be 1, and divide by 3; thus:—

$$3)\,\underline{1{\cdot}658011}$$
$${\cdot}552670$$

This quotient is the logarithm of the root ought, and again turning to the tables we find that 552668 is the logarithm of 357, and the characteristic being 0 we must write the natural number 3·57; therefore 3·57 is the cube root of 45·499593. Let those who doubt the simplicity and utility of logarithms attempt to extract the required root of the given number by the best known arithmetical process of evolution, and they will find not only that it is complicated and difficult to remember, but that the actual working will take ten times as long as is required to obtain the result by logarithms. To ascertain of what number some other number is the fifth, the seventh, or other high power is often altogether impracticable to the ordinary arithmetician without the use of logarithms; but the example given will suffice for the general reader.

Now, it must be understood that all logarithmic calculation is approximate only, and that it is a very good set of tables that gives the logarithms of natural numbers, as far as 100,000 (that I am using extends to 10,000 only), but the results obtained are very close to truth. The larger the natural number for which we can find the logarithm, the greater will be the certainty of accuracy in the results obtained. What then shall we say of a process which enables us to write without the use of tables the logarithm of such a number as 987·654321, and conversely to determine, also without the use of tables, that a given logarithm exactly represents the natural number—

·993020965034979006999?

The processes by which this can be done were explained many years ago by Mr. Oliver Byrne, but probably from his having employed a new system of notation, their application has been extremely limited, and to a large number of young students especially the entire subject of his treatises has been altogether unintelligible. The endeavour will here be made to popularise the system by retaining as far as possible the ordinary Arabic notation.

Some brief references to a few of Byrne's introductory remarks will add to the interest of the present study, and a few words on the manipulation and reduction of decimals will facilitate the accurate comprehension of the subject. Mixed decimal fractions are calculated precisely as whole numbers, all the care required being as to the placing of the decimal point. In addition and subtraction the decimal points must be ranged under each other. In multiplication we must in the product point off as many places from the right hand as there are decimal places in the multiplicand and multiplier combined. And in division we put the decimal point in the quotient as soon as the the integral portion of the dividend ceases to be divisible by the integral portion of the divisor. Any decimal fraction can be reduced to a mixed quantity by using the same multipliers as would be employed in the usual process of reduction, observing the rule of decimal multiplication; and any mixed quantity can be expressed in decimals by dividing step by step as in the reduction process. Thus to show and prove that £3·81875=£3 16s. 4½d., we have merely to employ the following processes:—

A.—
$$\begin{array}{r} 3{\cdot}81875\\ 20\\ \hline 16{\cdot}37500\\ 12\\ \hline 4{\cdot}500\\ \\ 4\\ \hline 2{\cdot}0 \end{array}$$

B.—
$$\begin{array}{r|l} 4 & 2\\ \hline 12 & 4{\cdot}5\\ \hline 20 & 16{\cdot}375\\ \hline & {\cdot}81875 \end{array}$$

Therefore
16s. 4½d.=·81875

In the first working the figure preceding the decimal points represents pounds, shillings, pence, and farthings respectively. In the second working we first write the farthings, and divide by 4, because there are 4 farthings in a penny; then prefix the 4 pence and divide by 12; and lastly prefix the 16 shillings and divide by 20: the resulting quotient is the decimal fraction sought. But decimal mixed quantities did not always possess the advantage of the simple notation now used; so that we may hope that something may hereafter be done to simplify Byrne's notation. The first notice of decimals appears to be that found in a tract at the end of Stevinus' *Arithmétique* in the collection of his works by his friend and pupil, Albert Girard; the tract is entitled *La Disme*. This collection was first published in Flemish, about the year 1590. At this early date decimals in the first place are termed primes and marked (1); those in the second place are marked (2), and called seconds, and so on; whilst all integers are characterized by the sign (0), which is put after or above the last digit; so that taking an example in addition it would stand thus:—

A.D 1590.
$$\begin{array}{rrrrrr} & (0) & (1) & (2) & (3) & (4)\\ & 3 & 4 & 6 & 1 & 2\\ 2 & 1 & 4 & 7 & 7 & 2\\ & 1 & 3 & 0 & 0 & 6\\ 2 & 4 & 0 & 0 & 4 & 9\\ \hline 5 & 0 & 1 & 1 & 3 & 9\\ & (0) & (1) & (2) & (3) & (4) \end{array}$$

A.D. 1878.
$$\begin{array}{r} 3{\cdot}4612\\ 21{\cdot}4772\\ 1{\cdot}3006\\ 24{\cdot}0049\\ \hline 50{\cdot}1139 \end{array}$$

At the present time most civilised nations not only recognise the importance and simplicity of decimals, but employ the metric system; but the English and Americans are not yet sufficiently enlightened to follow the example, although it may be hoped that hereafter they may become more wise. But all people are naturally averse to change, and hence it is that Arabic figures and notation were not introduced into Europe until about 900 years ago, and were but little used until after A.D. 1600. Leonardo Bonacci, a merchant of Pisa, introduced the Arabian system of digital arithmetic into Italy, and wrote the first treatise published in Europe about A. D. 1228.

In his *Philosophy of Mathematics*, Auguste Comte remarks upon the difficulty experienced in putting mathematical questions into equations, and says that "it is essentially because of the insufficiency of the very small number of analytical elements which we possess that the relation of the concrete to the abstract is usually so difficult to establish. Let us endeavour now to appreciate in a philosophical manner the general process by which the human mind has succeeded in so great a number of important cases in overcoming this fundamental obstacle." He first considers the creation of new functions, and observes that "in looking at this important question from the most general point of view, we are led at once to the conception of one means of facilitating the establishment of the equations of phenomena. Since the principal obstacle in this matter comes from the too small number of our analytical elements the whole question would seem to be reduced to creating new ones. But this means, though natural, is really illusory; and though it might be useful it is certainly insufficient. In fact, the creation of an elementary abstract function which shall be veritably new presents in itself the greatest difficulties. There is even something contradictory in such an idea; for a new analytical element would evidently not fulfil its essential and appropriate conditions if we could not immediately determine its value. Now, on the other hand, how are we to determine the value of a new function which is truly simple, that is, which is not formed by a combination of those already known? That appears almost impossible. The introduction into analysis of another elementary abstract function, or rather another couple of functions, for each would be accompanied by its inverse, supposes then of necessity the simultaneous creation of a new arithmetical operation, which is certainly very difficult."

Let us see how far Oliver Byrne's system meets the requirements referred to by Comte, and how far it can be applied for the development of mental logarithms. Decimal arithmetic, as now taught in schools, has been less than 150 years in use, so that the introduction of mental logarithms can scarcely be objected to on the ground that arithmetical knowledge has already reached perfection. Mr. Byrne explained that because the system of arithmetic invented by him requires numbers to be viewed under two aspects, and to distinguish it from other systems of operating upon numbers he has called it *dual arithmetic*. By this new art, a number representing any given magnitude, or the function of any given magnitude, may be made to assume a form composed of factors of whole numbers having a known relation to one another; and these derived whole numbers may be readily made to assume a variety of forms, each form always reducible to the given number or magnitude, and hence the derived numbers, by a peculiar arrangement, may be developed to suit different operations; and the factors produced, after such operations are performed, are easily converted into natural numbers, expressing the required results. An acquaintance with the operations of common arithmetic is all that is required to permit of the acquisition of a sufficient knowledge of dual arithmetic for the ready solution of almost innumerable intricate and difficult problems, and in its more complete development it enables the reasoning of the differential and other methods of analysis to be dispensed with. But as it is not here proposed to treat of the whole subject of dual arithmetic (which cannot be better studied than by consulting Mr. Byrne's own explanations), but merely to show one particular application of it, the theory of the art will only be referred to so far as is necessary to permit of the process being used. All that will be necessary will be to show how the dual logarithm of a natural number can be found, and then how to discover what natural number any given dual logarithm represents; for in the solution of any given problem the dual logarithms (which, as they can readily be discovered without reference to tables, we call mental logarithms) are manipulated in precisely the same way as the common logarithms given in the usual tables.

We are accustomed to represent that imaginary quantity, which is greater than any that can be named by $+\infty$ ("plus infinity"), and that other imaginary quantity which is less than any that can be named by $-\infty$ (minus infinity). The signs will be here used with the same signification. The bases of dual arithmetic are:—

Descending Branch.	Ascending Branch.
−∞	+∞
⋮	⋮
−999999	1000001
⋮	⋮
−999	1001
−99	101
−9	11
(1−1=) 0	2 (=1+1)
·9	1·1
·99	1·01
⋮	⋮
·9999	1·0001
⋮	⋮
·99999999	1·00000001
⋮	⋮
1 =	1

It will be observed that in the case of quantities belonging to the descending branch the power is smaller than its root; for example, the power of 0·9 is only 0·81. In the ascending branch the power is greater than the root. In the descending branch, the bases are greater and greater as they approach 1, but cannot be greater than 1; whilst in the ascending branch the bases are less and less as they approach 1, but cannot be less than 1. Numbers in the dual system of arithmetic are expressed by the continued product of the powers of one or more of the bases, which are seldom introduced into the figurate operations of the art. As, however, the difference between the decimal and the dual systems of notation will probably be best understood from an example we may observe that, according to the decimal or usual system of notation, 73·598 is merely an abbreviated method of expressing:—

$$7(10)+3+\tfrac{5}{10}+\tfrac{9}{100}+\tfrac{8}{1000}$$

which, if we use the commonly accepted method of expressing powers, will become—
$7(10)^{1}+3(10)^{0}+5(10)^{-1}+7(10)^{-2}+8(10)^{-3}$,
and we call 1, 0, −1, —2, −3, the powers of the base which, in the decimal system, is always 10. Now, in dual arithmetic it is only the powers of the dual bases which are registered, and each dual digit is the power of a different base; and in order to avoid any departure from the usual Arabic notation we will merely prefix DNA : or DND : to the figures, according as they belong to the ascending or descending branch, and suffix P^{1}, P^{2}, and so on, to indicate the power of 10 in the decimal system with which they are connected; thus:—

1·41421356 = DNA : 36094110 P.
141421·356 = DNA : 36094110 P^{5}.
·99922682 = DND : 00076343 P.

It will be obvious that there is no greater inconvenience in representing a dual number in this manner than in representing an ordinary Briggs's logarithm by prefixing *log.*; and it may here be mentioned that it is proposed to indicate the dual logarithm or mental logarithm by prefixing DL : to the ordinary Arabic numerals in the same way. When some of the dual digits belong to the ascending and some to the descending branch either prefix, DNA : or DND : may be used, care being taken to place a negative sign over the digits belonging to the other branch; thus—

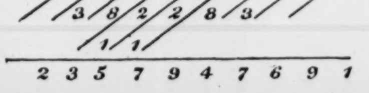
DNA : $3\bar{5}\bar{0}\bar{1}4738$P^{4} = DND : $\bar{3}501\bar{4}\bar{7}\bar{3}\bar{8}$P^{4}.

For the sake of uniformity it is preferable in such cases always to use the first form. It should be well understood that, although we have given 141421·356 = DNA : 36094110P^{5}, many dual numbers may be found to represent the same natural number; and it is a peculiarity of the system that, although a given natural number may be represented by a vast number of dual numbers, yet every dual number which represents such given natural number may be almost instantly reduced to one and the same dual logarithm. Dual digits are intimately connected with binomial coefficients, and reference to the arithmetical triangle, formed when the binomial coefficients for the several powers are written down consecutively, will assist the memory for converting dual number into natural numbers, and *vice versa*. A line of units is written horizontally, and a second line vertically, the remaining squares being filled by a number equal to those in the squares immediately above and to the left of it; thus:—

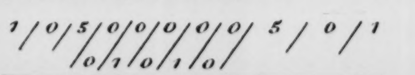
1	1*a*	1*b*	1*c*	1	1	1	1	1
1*a*	2*b*	3*c*	4	5	6	7	8	&c.
1*b*	3*c*	6	10	15	21	28	36	&c.
1*c*	4	10	20	35	56	84	120	
1	5	15	35	70	126	210		
1	6	21	56	126	252			
1	7	28	84	210				
1	8	36	120					
1	9	45						
1	10							
1								

Now, we can see at a glance that taking the diagonals consecutively—first, *a*, *a*; then *b*, *b*, *b*; then *c*, *c*, *c*, *c*; and so on—we have the coefficients of the simple quantity, of the square, of the cube, and so on respectively, and these are precisely the operative numbers which we shall hereafter find very useful for giving us our mental logarithms. In the dual system of arithmetic these numbers are used to find the powers of the bases ·9; ·999; ·99; and so on, as well as the powers of the bases 1·1; 1·01; 1·001; and so on; but it must be remembered that in the descending branch the second, fourth, sixth, and other *even* coefficients must be regarded as negative and used accordingly.

The position of the dual digits is reckoned from the left hand; so that in the quantity DNA : 36094110P^{5}, the 3 is said to be in the first position, the 6 in the second, and so on. In the first place, then, we must know how to find the natural number answering to a single digit of either branch in any position. Assuming as before that the working of an example is the readiest means of elucidation, let us find the value of DNA : 9 in the first position. The arithmetical triangle gives us, if we read diagonally for 9 either up or down, 1, 9, 36, 84, 126, 126, 84, 36, 9, 1, and we write these in such a manner that the units shall form one horizontal line, the tens and hundreds running diagonally to the *left* beneath them, thus:—



Consequently, as there is nothing to denote that the power of 10 is other than simple, we say that 2·357947691 = DNA : 9 in the first position. When the dual digit stands in the second position, we proceed in the same way, except that we write 0 between each diagonal. Let us, for example, find the natural number equal to the dual digit 5 in the second position; that is, DNA : 05. The arithmetical triangle gives us the coefficients or operative numbers as they are called in dual arithmetic, and we write—



so that 1·0510100501 = DNA : 05. Upon the same principle, two cyphers, 00, must be inserted between the diagonals when the dual digit is in the third position; three cyphers, 000, when the dual digit is in the fourth position, and so on. We shall presently see that this property of numbers can be very extensively utilised. In arithmetical calculations it is usually sufficient for all practical purposes if we can ensure accuracy to eight places of figures, and we shall observe, if we take any dual digit in the fifth, sixth, seventh, or eighth position, that in the corresponding natural number all the places except one in the decimal fraction portion are filled with cyphers, the exception being the fifth, sixth, seventh, or eighth place, as the case may be, which contains a digit identical with the dual digit. It is unnecessary to show the working, but it will be found that—

DNA : 00002000P = 1·00002000
DNA : 00000070P = 1·00000070
DNA : 00009358P = 1·00009358

The advantage of utilising this fact is, that we can obtain a dual number correct to eight places of figures corresponding to any given natural number by the calculation of the first four figures only; which calculation can be performed in a few seconds. The natural number corresponding to the last four dual digits is written down, and this is manipulated with the operative number furnished by the arithmetical triangle. The unfound dual digits may be worked off in any order whatever; but care must be taken to locate the results in periods corresponding to the position of the dual digit sought; that is to say, when operating for dual digits in the first position the results must be written down in single figure periods; when operating for dual digits in the second position in two-figure periods; and so on. To take an example, let it be required to reduce DNA : $3\bar{5}\bar{0}\bar{1}4738$P^{4} to a natural number. We neglect the decimal and proceed thus:—

```
DNA : 00004738 = 1|0 0|0 0|4 7|3|8....1)
                  |3 0|0 0|1 4|2|1....3} operatvs.
                  |  3|0 0|0 1|4|2....3} for DNA :3
                  |   |1 0|0 0|0|5....1)
                 ------------------------
DNA : 30004738 = 1 3 3 1|0 6 3 0|6
                        |1 3 3 1|1..−1
                 ------------------------
DNA : 300̄14738 = 1|3 3|0 9|2 9|9 5..+1  )
                  |  6|6 5|4 6|4 9..−5  } operatives
                  |   |1 3|3 0|9 3..+10 } for DND : 05
                  |   |   |1 3|3 1..−10 }
                  |   |   |   |  7 .+5  )
                 ------------------------
DNA : 35̄0̄1̄4738 = 1 2 6 5 7 0 1 1 5
```

∴ DNA : $3\bar{5}\bar{0}\bar{1}4738$P^{4} = 12657·0115

It will be observed that the operative numbers are always used as ordinary multipliers, and that all positive products are added, whilst all negative products are subtracted, the final results obtained being the natural number sought. We have seen that DNA : 00004738 = 1·00004738; and hence, generally, DNA : 0000 *v x y z* = 1·0000*v x y z*; when *v x y z* are digits occupying positions like 4738 in the example. But this is not all, for it will be found that DND : 00004378 is equal to 1·00000000 − 00004738 = ·99995262; and generally DND : 0000 *v x y z* = 1·00000000 —·0000*v x y z*; and the knowledge of these facts can frequently be utilised in practice.

The rule for the reduction of common to dual numbers is of course the converse of that which we have just been considering. To find the dual digits for the first, second, third, and fourth positions, we first take the common number corresponding to a dual digit of either branch, so that the leading figures of this number may approach the leading figures of the given number; then the dual digits which have to be applied to bring the number selected to the given one will be the other digits of the required dual number. Owing to the properties just referred to, it will be obvious that when the dual digits for the first four positions have been found, the remaining four may, when accuracy to eight places is sufficient, be run in at one operation. By way of example, let it be required to reduce 12657·0115 to a dual number. We will explain the steps of the process after working it.

Given number = 126570115.

```
DNA : 3           1 3|3 1|0 0|0 0|0....+1
                     |6 6|5 5|0 0 0....-5
                     |  1|3 3|1 0 0....+10
                     |   |  1|3 3|1....-10
DND : 05             |   |   |   |7....+5
                  ---------------------
                  1 2 6 5|7 6 7 7|6
DND : 0001               |1 2 6 5|7....-1
                  ---------------------
                  1 2 6 5 6|4 1 1 9
DNA : 00004                 5 0 6 2....4
DNA : 000007                  8 8 6....7
DNA : 0000003                   3 8....3
DNA : 00000008                  1 0....8
                  -----------------
                  1 2 6 5 7 0 1 1 5
```

We have now only to collect the dual digits and represent the decimal point in the given power by the index of the power, and we have: 12657·0115 = DNA: $3\bar{5}0\bar{1}4738P^4$, which proves the correctness of both reductions. With regard to the steps in the process it could be instantly determined by inspection that the common number 133100000 = DNA: 30000000 was the nearest number to 126570115. As the selected number was too large, we knew that the next dual digit must belong to the descending branch. The number 126576776 was also too large, so that the descending branch had again to be used, and we obtained DNA: $\overline{35010000}$ = 126564119, which is smaller than the given number; therefore, the dual digits in the fifth, sixth, seventh, and eighth position will belong to the ascending branch, and by using such multipliers as will enable us to make up the deficiency we obtain 4738 for the remaining four places.

As there should now be no difficulty in reducing a given natural number to a dual number or in finding the natural number corresponding to a given dual number of either branch, all that remains is to show the method of finding the logarithm of a given dual number; that is to say, the method of calculating a dual logarithm, and then to explain the method of reducing a dual logarithm to a natural number. The first thing to be considered is whether the dual number belongs to the ascending branch, to the descending branch, or is mixed; as the method of reduction differs in each case.

Rule 1.—To reduce a dual number of the ascending branch to a dual logarithm (DL:), regard the given dual number as a natural number, add 31018 times the first dual digit *plus* 33·09 times the second dual digit; then subtract 5 times the first three dual digits, a cypher (0) being placed after each, and the remainder, *minus* half the fourth dual digit, will be the dual logarithm sought.

Rule 2.—To reduce a dual number of the descending branch (of eight consecutive dual digits) to a dual logarithm (DL:), regard the given dual number as a natural number, add 5 times the first three dual digits, supposing a cypher placed after each; 36052 times the first dual digit; and 34 times the second dual digit. The sum will be the dual logarithm sought, and less than one unit out of truth.

Rule 3.—To reduce a dual number consisting of eight consecutive dual digits, some of which belong to the ascending and some to the descending branch, treat those belonging to each branch separately; subtract one result from the other and the difference is the dual logarithm sought; it belongs to that branch which has the greater number.

Remark.—Dual logarithms are always whole numbers; those of the ascending branch have DLA: prefixed to them; those of the descending branch have DLD: prefixed. It must be remembered that the dual logarithm of 2 is DL: 69314718; and that the dual logarithm of 10 is DL: 230258509, as these logarithms are so frequently required that it is unnecessary to recalculate them each time.

Rule 4.—To prepare a dual logarithm for reduction to its corresponding dual number, find the difference between the given DL: and some multiple of DL: 230258509, or of DL: 69314718, and repeat the process until the remainder is less than half of DL: 230258509, and ultimately less than half of DL: 69314718. When necessary complete this final remainder to 8 places by prefixing cyphers on the left; then apply one or other of the following rules according as such remainder is a DLA: or a DLD:

Rule 5.—To reduce a prepared dual logarithm of the ascending branch to its corresponding dual number, write down the given DLA: and add thereto 500,000 times the first figure (increased by 1 when the second is 5 or upwards); subtract 31,018 times the first figure from the sum; add 5000 times the second figure of the remainder, subtract 33·09 times the same figure. And, then add 50 times the third figure, *plus* half the fourth figure. The sum will be the dual number sought.

Rule 6.—To reduce a prepared dual logarithm of the descending branch to its corresponding dual number, write down the given DLD: and subtract therefrom 536052 times the first figure; then subtract 5034 times the second figure of the remainder; and lastly subtract 50 times the third figure of the new remainder. The final remainder will be the required dual number.

Remark.—In applying the fifth and sixth rules the figure multiplied must not alter in the operation, but must reappear in the remainder.

We have placed these rules together, in order to facilitate reference to them, and will now show their application in practice. To economise space we will take one example, which will necessitate the application of all the rules. Let it, therefore, be required to find the DL: of 12657·0115, and prove that the DL: found is the correct one. As we have already found that DNA: 35014738 P⁴ is a DN: corresponding to the natural number 12657·0115, and since if our thoughts did not run precisely in the same direction, the resulting DN: would be different we will not recalculate it; but proceed at once to reduce DNA: $3\bar{5}0\bar{1}4738$ P⁴ to a DL: which is thus effected:—

Separating the branches in Rule 3, we have DNA: 30004738, and DND: 05010000 to operate upon. We neglect the P⁴ for the present and applying Rule 1 to the DNA: and Rule 2 to the DND: the workings will stand thus:—

Firstly	30004738
31018 × 3 (the first dual digi) =	93054
	30097792*
30 00 00 × 5	=1500000
DNA: 30004738	=DLA: 28597792

* The second dual digit being 0, the constant 33·09 is not used.

Secondly	05010000
00 50 00 × 5	25000
36052 × 0 (the first dual digit)	0
34 × 5 (the second dual digit)	170
DND: 05010000	=DLD: 05035170

Lastly	DLA: 28597792
	DLD: 05035170
	DLA: 23562622
P^4 = 230258509 × 4	=DLA: 921034036
DNA: $3\bar{5}0\bar{1}4738P^4$	=DLA: 944596658

Consequently we find that the natural number 12657·0115 is equal to DLA: 944596658, and we have now to prove that this is correct. We first apply Rule 4 to eliminate the powers of 10

Given	DLA: 944596658
230258509 × 4 = P^4 =	921034036
Apply Rule 5 to	23562622
500000 × 2 (first dual digit)	+ 1000000
	24562622
31018 × 2 (first fig. of rem.)	− 62036
	24500586
5000 × 4 (second fig. of rem.)	+ 20000
	24520586
33 × 4 (second fig. of rem.)	− 132
	24520454
50 × 5 (third fig. of rem.)	+ 250
Half of fourth fig. of rem.)	1
DLA: 944596658	=DNA: 24520705P⁴

The remainder of the proof is simple enough, since it is obvious that we have merely to reduce DNA: 24520705 P⁴ to a natural number, by the process with which we are already familiar; thus:—

```
DNA : 2     = 1 2 1 0|0 0|0 0|0
                  |4 8|4 0|0 0 0
                  |   |7 2|6 0 0     DNA : 04
                  |   |   |4 8|4
                  |   |   |   |1
              -----------------
DNA : 24    = 1 2 5|9 1 3|0 8 5
                   |6 2 9|5 6 6
                   |    1|2 6 0      DNA : 005
                   |     |    1
              -----------------
DNA : 245   = 1 2 6 5|4 3 9 1|2
                     |2 5 3 0|9      DNA : 0002
                     |       |1
              -----------------
DNA : 2452  = 1 2 6 5 6 9|2 2 2
                         |8 8 6  (7
                              7  (5
              -----------------
DNA : 24520705 = 1 2 6 5 7 0 1 1 5
```

∴ DNA: 24520705P⁴ = 12657·0115

Now a very peculiar circumstance may be noticed in connection with this series of reductions—in obtaining the DL: from the natural number we passed by way of one DN: whilst, in calculating the natural number from the DL: we passed by way of an entirely different DN: yet both these dual numbers are alike reducible to the same natural number. Moreover, if we reduce DNA: 24520705 P⁴ to a DL: we shall find that we again obtain DL: 944596658 correct to eight places of figures; which is certainly strong evidence in favour of the accuracy of Byrne's rules, and should suffice to give universal confidence in the importance of the art.

In conclusion it must be understood that it is not proposed to supersede ordinary logarithmic tables by mental logarithms, but to use the dual arithmetical system as an auxiliary to and extension of the usual system of logarithmic calculation; and it will be found when the dual system is once mastered, as it quickly can be with a little attention and perseverance, that a great variety of problems, the solution of which usually involves complicated and laborious processes, can be accurately and readily solved without tables, without mental labour, and by the application of simply and easily remembered rules. For example it can quickly be ascertained that if—

$$3{\cdot}01416x^5 - 28{\cdot}233x^4 + 923{\cdot}7x^3 + 1234x^2 - 1862x = 1609149128,$$

then x is equal to 56·43657, which would usually require much labour; and the dual system equally facilitates the calculation of angular magnitudes and trigonometrical lines, the solution of plane triangles, without the use of tables, the determination of the numerical value of elliptic and hyperbolic functions, the extraction of the roots of equation of all degrees, and indeed the solution of almost innumerable problems which have hitherto been considered to require great mathematical skill; all this moreover can be done by anyone acquainted with the ordinary rules of arithmetic. But inasmuch as the present object is not to demonstrate the value and scope of dual arithmetic, but merely to show by a practical application of it that its advantages may be thoroughly utilised without the use of a special notation, these few references will suffice, and it is hoped that after the examples which have been worked, and the explanations given, this will be fully acknowledged, and that hereafter the system will be far more generally studied by all classes.

HOT WATER AS A RESTORATIVE FOR PLANTS.

M. Willermoz, in the French *Journal of the Society of Practical Horticulture*, relates that plants in pots may be treated with hot water when out of health, the usual remedy for which has been re-potting. He says that when ill health ensues from acid substances contained or generated in the soil and this is absorbed by the roots, it acts as a poison. The small roots are withered and cease their action, consequently the upper and younger shoots of the plant turn yellow, and the spots with which the leaves are covered indicate their morbid state. In such cases the usual remedy is to transplant into fresh soil, clean the pots carefully, secure good drainage, and often with the best results. But the experience of several years has proved with him the unfailing efficacy of the simpler treatment, which consists of watering abundantly with hot water at a temperature of about 145° Fahrenheit, having previously stirred the soil of the pots so far as might be done without injury to the roots. Water is then given until it runs freely from the pots. In his experiments the water first came out clear, afterwards it was sensibly tinged with brown, and gave an appreciable acid reaction. After this thorough washing the pots were kept warm. Next day the leaves of two Ficus elastica so treated ceased to droop, the spread of black spots on the leaves was arrested, and three days afterward, instead of dying, the plants had recovered their normal look of health. Very soon they made new roots, immediately followed by vigorous growth.

RECENT AMERICAN AND FOREIGN PATENTS.

Mr. Sylvester Snell, of Watertown, N.Y. has patented an improvement upon that form of animal trap in which the weight of the animal upon a tilting platform is made to close the doors of the cage. The inventor adds an ingenious mechanical device, operated by the weight of the animal's fore feet, which unceremoniously precipitates him into a pit below.

An improved photographic camera shutter, invented by Mr. A. Johnson, of Kewanee, Ill., consists of an interior swinging shutter of novel construction, arranged to shut off the light passing through the camera tube, the object being to provide a means of opening and closing the tube without the knowledge of the sitter.

Mr. G. L. Reynolds, of Oakland, Cal., has made an improvement in the class of window screens, in which the upper and lower wire screens are attached at one end directly to the sashes, so that when the latter are raised or lowered to open them, the screen will be extended over the opening and thus exclude flies, mosquitoes, or other insects without excluding air. The improvement consists in journaling a screen roller in a groove formed in the meeting rail of a sash, and in attaching to said screen roller one balance cord of the journal of the roller and the other balance cord to the sash.

A new leather dressing compound, for boots and shoes, harness, trunks, &c., designed to impart a lustrous black gloss, as well as to preserve and protect the leather, has been patented by Messrs. Norman Quinlan and J. H. Quinlan. Jr., of Glen Falls, N.Y. It is made of shellac, ivory black, alcohol, castor oil, and turpentine in certain proportions.

Mr. J. F. Johnson, of Yocum Station, Va., has made an improvement in pen holders, designed to render the pen yielding to pressure upon the point, and to adapt it to be carried in the pocket. It consists in arranging the pen socket in a tubular case, so as to slide freely, with a spiral spring behind the same, which tends to project the pen beyond the tube to its working position, the pen being retracted in the tubular case by means of a stud extending through a longitudinal slot in the said case, and secured by being turned axially into a notch.

Mr. David Healy, of Los Angeles, Cal., has patented a waste trap designed to prevent the escape of sewer gas, to prevent siphoning, and to supply hot and cold water to a basin through concealed pipes. It has two water seals arranged in a peculiar manner, and a float valve which when subjected to suction adheres more closely to its seat. thus preventing the removal of water from the trap.

An improved blackboard arrangement has been invented by Mr. H. W. Eastman, of Baltimore, Md., in which the blackboard proper is pivoted in a frame, in which it slides up and down, so that it may be reversed in position to bring either side to the front. The special point consists in balancing the blackboard by means of a sliding frame adapted for holding alphabetical or arithmetical tablets, said board and tablet frame being connected by ropes which pass over pulleys at the top of the fixed frame, in which the movable parts slide vertically; the arrangement being such that the blackboard is prevented from turning on its pivots when the tablet holder is lowered into the required position behind it.

An improved buckle for harness, which may be disengaged from the strap or trace in connection with which it is used, without the necessity of drawing upon the strap or trace to release the buckle tongue, has been patented by Mr. R. J. S. Graham, of 79, Murray-street, New York city (care of Edward A. Boyd). It has an open frame, which may be drawn together or spread apart by an adjusting screw, and has a movable bar which hooks over the sides of the frame when the buckle is in use, but is released, so as to liberate the buckle tongue, by turning the adjusting screw.

Mr. J. W. McGarrett, Jr., of Nashua, N.H., has devised a movable copy holder for children when learning to write, the advantage of which is that the copy may be moved down the page as the writing progresses, so that the learner may always have his copy before him, instead of using the line last written as a copy for the next. The holder is made of tin, wood, or other suitable material, and has flanges upon its edges to receive the copy slip, and feet which support it at the right inclination.

Mr. Thomas J. Paradine, of Erie, Pa., has patented a new safety valve and cock for steam cylinders, which is so constructed that the opening of the cock takes place whenever the engine is exhausting. The water of condensation is thus allowed to pass through the upper chambered part of the valve and the exit spout to the outside, relieving the cylinder of the high pressure caused by the compression of water between the piston and cylinder head after the exhaust pipe is closed.

A new portable hand windlass, whereby it is claimed two men can do work which would otherwise require eight or ten men, has been patented by Mr. Orleff Fredrickson, of New York city. The mechanism is simple and compact, and the device is well suited for nautical use.

Mr. Jacob Mackey, of Steubenville, Ohio, has devised a new tuyere for blast furnaces, which is made in two parts, and is provided with closed bottoms to obviate the necessity of joints and prevent leakage.

FOREIGN SCIENCE.

The utilization of the Niagara falls for industrial purposes has, for some time past, occupied the attention of capitalists in the United States. Last year a resident of Buffalo formed an idea of making a series of experiments, having for their aim, the demonstration of the possibility of transmitting (by means of compressed air) the immense hydraulic power of the falls, as far as the City of Buffalo, at the mouth of Lake Erie, a distance of more than 35 kilometres. The experiments having been carried out, have, it appears, given a very satisfactory result, and a public company has been formed (of which Senator Pierce is the president) for working the scheme. A very large capital will, as a matter of course, be required to enable this vast undertaking to be properly executed. A considerable sum has already been subscribed, and it may, therefore, be expected that active steps will very soon be taken. The principal parts of the hydraulic mechanism have already been placed at the bottom of the Fall, and when complete will be of sufficient power for lifting 350,000 gallons of water per minute.

On Wednesday, the 28th of August, Mr. Henry Giffard's great captive balloon was inflated, and made its first ascent at the Tuileries, in the presence of an enormous concourse of spectators. This balloon far surpasses in size anything of the kind ever before attempted. It will be remembered that in May, 1869, a balloon, constructed by the same indefatigable aëronant, was exhibited at the Cremorne Gardens, London. This balloon was 27 metres in diameter, total height 37 metres, and had a cubical capacity of 12,000 metres. The one now on exhibition in Paris is 36 metres in diameter. Its total height is 55 metres (or nearly 200 feet), superficial area 4,000 metres, and cubical capacity 25,000 metres. The car is in the form of an annular passage or gallery 6 metres in exterior diameter, and 1 metre in width. The balloon is composed of several layers of indiarubber cloth and other fabrics, in all 1,469 separate pieces. When inflated, it is visible at a distance of 20 miles from Paris.

The session of the French Association for the advancement of Science was brought to a successful conclusion at Paris on August 29th. Its next Congress will be held at Montpellier next year.

Professor Edison has brought out another invention, styled the "Megaphone," an instrument for collecting sounds from a great distance, and rendering them audible.

A novel application of the telephone to magnetic observations has been invented by M. de Parville, scientific writer on the *Journal des Debats*, and other French papers. He demonstrates the possiblity of determining exactly the position of the magnetic meridian by means of the telephone.

A new Scientific Society has recently been formed in Paris, under the title of the "Union des Ingenieurs."

At the meeting of the Meteorological Section of the French Association for the advancement of Science, Mr. Collins, the chief the meteorological department of the *New York Herald*, read a paper on the movements of storms while they are traversing the Atlantic, and the possibility of predicting the time at which they may be expected to arrive in Europe.

The "Chemister Zeitung," announces the recent discovery of rich seams of coal in Peru, which will no doubt help to supply a want long felt in that part of South America.

A magnificent bronze statue, for which 120,000 francs has been subscribed, is to be erected in memory of M. Liebig. Several designs have been sent in, and the first prize of 200 francs has been awarded to M. Wagmuller, of Murich.

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Proceedings of the Institute.

ON 30th September, the Executive met for dispatch business, Admiral J. H. Selwyn, V.P., in the chair. After the confirmation of the minutes of the last meeting; the appointment of the President and Admiral Selwyn, as representatives of the Institute at the International Congress on Patent Laws and Trade Marks, was approved. A discussion then ensued as to general business, the arrangements for the forthcoming session, and the desirability of a public dinner taking place in November.

N.B. The American (U.S.) Commissioner of Patents, in a recent report on the U.S.A. Patent Office, remarked that it may be safely said that two-thirds of the manufacturing interests of the country are based upon patents. This is a very significant fact, considered in connection with the high position of the United States in the late Exhibition at Philadelphia, and the present one at Paris.

POSTPONEMENTS.

We are compelled to postpone a large portion of the British Association Report and several Reviews, also "Hymettus to J. G. R." (poetry).

Monthly Notices.

The Iron and Steel Institute held its meeting at Paris during the past month. The local hon. secretary was Mr. H. Chapman. The programme comprised the president's address, also papers by Prof. Jordan, Paris, "On the Mineral Resources of France;" Prof. Richard Akermann, Stockholm, "On some Studies relative to the Present State of the Iron and Steel Manufacture, made at the Paris Exhibition;" M. Euverte, Terre Noire, "On Homogeneous Steel;" Mr. Daniel Adamson, "On the Mechanical and other Properties of Iron and Mild Steel;" M. Marché, "On Certain Aspects of the Steel Manufacture;" M. J. S. Périssé, "On the Ponsard Furnace for the Manufacture of Steel;" Messrs. Sydney G. Thomas and Percy C. Gilchrist, Blaenavon, "On the Elimination of Phosphorus from Pig Iron in the Bessemer Converter;" Mr. R. P. Rothwell, New York, "On the Low and Strong Water Gas Processes." The members received invitations to visit the works of Creuzot, those of Terre Noire, and those of Hayange, Lorraine.

The death of M. J. Fordos, the Vice-President of the Chemical Society of Paris is announced. He was well known for his investigations of the colouring matters derived from woody substances, and his examination of sulphur and its derivatives.

Mr. Darwin and Prof. Asa Gray have been elected corresponding members of the *Académie des Sciences* of Paris.

A rich deposit of coal, sufficient for the supply of all South America for a long period, has been discovered at Chala-Alta, in Peru, according to the "Chemiker Zeitung."

M. de Sainte-Claire's Dictionary of English, French, and German Idioms (Part I.) has just made its appearance. The work is to contain 285,000 idiomatic or constructively difficult phrases, and will be completed in about fourteen 3s. parts. The publishers are Messrs. Maclachlan and Stewart, of Edinburgh. The London agents are Messrs. Dulau and Co.

Miss Buckley has in the press an illustrated work called "The Fairyland of Science: Chapters for Children." Mr. Stanford is to publish it.

An Exhibition of sanitary appliances and selected articles of domestic use and scientific applications thereto will be held at Stafford from the 2nd to the 19th of October.

Prof. Fischer has been found poisoned in the physical laboratory of the Gymnasium at Prague. Dr. Fischer has been engaged on some experiments with the cyanide of potassium, and it is evident that he fell a victim to this investigation.

The decease of M. Ernest Quetelet, long connected with the Royal Observatory at Brussels, which was built fifty years ago, and of which his distinguished father, the late Prof. A. Quetelet, was the first, and for more than forty years, director, is announced.

The danger of allowing coal dust to be diffused in collieries has been brought before the Académie des Sciences by M. Simonin. He shows that a small amount of heat liberates explosive gas from the finely divided coal, and thus induces dangerous explosions. M. Simonin thus confirms the statements of Mr. Galloway.

Gustav Wallis, the botanist, died at Cuença, in Ecuador, on the 20th of June. His exertions in South America, in which he was aided by the Dutch cultivators, have helped the introduction of several hundred new varieties of South American ornamental plants.

Mineral Statistics of the United Kingdom for 1877, just issued by the Stationary Office, informs us that the total value of the metalliferous and earthy minerals and coal raised last year was £58,398,071 sterling. The coal raised was 134,610,763 tons, valued at £47,113,767. Of iron ore we raised 16,692,802 tons, of the value of £6,746,668. The metals obtained had a value of £18,742,960, and the useful earthy minerals and salt is valued at £2,424,679. The total value being £68,281,406.

The death of Mr. John Penn, the eminent engineer, is announced.

The Scientific Review.

OCTOBER, 1878.

A NOTABLE RECOGNITION OF THE INVENTOR'S CLAIMS.

Magna est veritas et prevalebit is a well known aphorism, which has just received another practical application. After years of strenuous opposition to the claims of the inventor to a proprietary interest in his inventions, the *Times* has succumbed to the power of the truth in regard thereto; that journal recently, in a leading article referring to the recent Congress on la Propriété Industrielle at Paris, and the precedent Patent Congress of Vienna, having published views decidedly favourable to the maintenance of the Patent Laws, as a means of enabling the inventor to obtain remuneration for the efforts of his ingenuity, though some fallacious notions on the subject are still cherished by the writers of the *Times*, as will be readily perceived upon careful perusal of the following attempt at proving that patent right is essentially different from copyright.

"An author may," says the writer, "have conceived thoughts new in the history of mind, yet any one who reads his book may pirate them. His property is only in the particular expression of the ideas in language. Copyright in ideas would have curtailed one half of the poetry between Byron and Mr. Tennyson, and between the dawn of Mr. Tennyson's popularity and the present day. Whether literature would have greatly lost is nothing to the purpose. It may be said that an inventor is allowed no larger property than an author. He can acquire no monopoly in a natural principle, but only in its application to particular processes. The telephone patent borders very closely on this line; but in any case the distinction, so far as manufacturers are concerned, is one without a difference. It is analogous to a law which should forbid thinkers to apply Mr. Darwin's principle of evolution to the natural history of man." All which, as far as the truth of the case is concerned, simply means that inventions are not books, nor are the latter inventions; for as far as the patent system is concerned, it is one of protection to ideas *embodied as an invention of practical availability*. Copyright being for ideas *embodied in words practically available to form a book*. After the jumble of fallacy and truth above referred to, we have a statement not vastly unlike it, namely, "Natural right to a patent for what are called inventions in truth there is none," the reply to which is that there is no *natural right* to any property, except what can be kept *vi et armis*, as when the "strong man, armed, keepeth his palace."

But the great interest for us in the *Times* article is to be found in the following statements, which acknowledge the propriety and expediency of the patent system. "The positive objections in point of expediency to the grant of patents are themselves strong. Some slight link in a process once patented often bars further advance, like a robber baron's castle at a river ford. But want of natural right and questions of practical inexpediency have been altogether overruled by the demonstration of the *general utility of a patent law to manufacturing interests themselves*. The bribe of a patent is proved, especially by the example of the United States, to be so extraordinarily stimulating to ingenuity that the public has resigned its title to forbid monopolies. Suggestions have been made that inventiveness might be developed equally well at some less cost of inconvenience to unpatented industry. Compulsory royalties or licences for the use of an invention were proposed at the previous Patent Congress at Vienna. At present the patentee has an exclusive right to apply his process. He may manufacture ill, and may forbid a more skilful mechanician to manufacture well. He may even choose to lay his invention on a shelf, and, within the limits of his patent, refuse it to the manufacturing world altogether. Genius is irritable, and may be sulky. An economy of labour like the sewing machine, or an application of science like the telephone, might, however unlikely the act of barbarism, have been practically locked up from a nation for the whole duration of the patent rights." We regret that want of space prevents further quotation, for the article is an able argument for the *expediency* of Patent laws, which are therein very happily characterised as offering a "bonus" to the inventor, though, by the bye, this term seems inconsistent with describing them as proffering a "bribe," as alluded to above.

Now this article has a significance far beyond a mere newspaper utterance, for whatever the *Times* speaks of in such a decided manner may be safely reckoned as being an iteration of the public opinion of the time, and its publication is no small feather in the cap of the Inventors' Institute, including such Patent Law advocates as Sir Antonio Brady, Admiral J. H. Selwyn, and Mr. F. W. Campin, who have worked on through good report and evil report, being a practical testimony that their persistent efforts on behalf of the Inventor's Cause have not been without useful results.

Reviews.

THE TELEPHONE AND PHONOGRAPH.

"The Speaking Telephone, Talking Phonograph, and other Novelties." By George Priscott. Fully illustrated. New York: D. Appleton and Co. 1878.

When Franklin drew from the clouds the electric spark upon the cord of his kite, it seemed obvious that electricity might be made use of for the purpose of telegraphy; and more than one hundred years ago Lesage established a telegraph in Geneva by the use of frictional electricity. But this force had very little power when transmitted over a long distance, and that little was practically uncontrollable, and therefore useless for telegraphy.

When galvanism was discovered, at the beginning of the present century, and the voltaic battery invented, it was at once supposed that this new form of electricity might work a telegraph, and ten years later the chemical telegraph was invented by Coxe, in Philadelphia. Under this system, the two wires from a galvanic battery were made to approach each other in a cell of water. When the galvanic circuit was closed, the water between the opposite poles, which were near each other, was decomposed, and a bubble of hydrogen rose to the surface, as the bubble from champagne does in the wine cup; and the observer, seeing it, knew that a current was passing, and that the bubble was the signal. But it was evanescent

> "—— like snow falls in the river,
> A moment white, then melts for ever."

In 1820, Oersted discovered that an electric current would deflect a magnetic needle, and Arago and Davy simultaneously discovered that a piece of iron, surrounded by a spiral wire through which a current of galvanism passed, would become magnetic. From this fact Ampère deduced the hypothesis that magnetism is the circulation of currents of electricity at right angles to the axis joining the two poles of the magnet. That was a brilliant deduction; but no practical result was produced from it until 1825, when the first simple electro-magnet was made by Sturgeon, who bent a piece of wire into shape of a horseshoe, and wound a fine wire round it in a helix, through which the galvanic current passed; and he found that the horseshoe wire was magnetic as long as the current flowed. Then at once an attempt was made with Sturgeon's magnet to produce the electro-magnetic telegraph, but without success. The difficulty was that the magnetic power could not be transmitted from the battery for more than fifty feet with Sturgeon's magnet, which was, therefore, entirely useless for the purposes of a telegraph; and, in 1829, Professor Barlow published a scientific demonstration in England, which was accepted by the scientific world, that an electro-magnetic telegraph was impossible; which was true in the then state of knowledge.

In 1830, Professor Henry deduced from the hypothesis of Ampère the invention now known as the compound electro-magnet. He also answered the demonstration of Barlow, and proved that the electro magnetic telegraph was possible. In the same year he set up an electro-magnetic telegraph in Albany, over a line of a mile and a half in length, using a polarised relay, the armature of which was pivoted so as to vibrate between its poles as the current of electricity was reversed, thus transmitting intelligence by sound.

In 1831, Professor Faraday made known his discovery of the phenomenon of magnetic induction.

In 1834, Gauss and Weber constructed a line of telegraph, containing about 15,000 feet of wire, which was operated by the magneto-electric currents generated in a coil of wire when the latter was moved up or down upon a permanent magnet, around which it was placed. The slow oscillations of a magnetic needle, caused by the passage of the current, and which were observed through a glass, furnished the signals for correspondence. Sir William Thomson has since greatly improved the latter apparatus, and thereby given us the beautifully sensitive mirror galvanometer which bears his name.

In 1837, Steinheil discovered the important fact that the earth would serve as a conductor, thereby saving one wire in forming a circuit: Cooke invented his electro magnetic semaphore, known as the needle telegraph, in which needles swing upon the face of a dial, just as the vanes of the old semaphores swung on the hill tops: Morse invented his electro-magnetic telegraph, which he put in operation between Baltimore and Washington in 1844: and Page discovered that a musical sound accompanies the disturbance of the magnetic forces of a steel bar, when poised or suspended so as to exhibit acoustic vibrations.

In 1861, Reiss discovered that a vibrating diaphragm could be actuated by the human voice so as to cause the pitch and rhythm of vocal sound to be transmitted to a distance, and reproduced by electro-magnetism.

In 1872, Stearns perfected a duplex system, whereby two communications could be simultaneously transmitted over one wire; and, in 1874, Edison invented a quadruplex system for the simultaneous transmission of four communications over the same conductor.

In 1874, Gray invented a method of electrical transmission by means of which the intensity of the tones, as well as their pitch and rhythm, could be reproduced at a distance; and subsequently conceived the idea of controlling the formation of electric waves by means of the vibrations of a diaphragm capable of responding to all the tones of the human voice, thus solving the problem of the transmission and reproduction of articulate speech over an electric conductor.

In 1876, Bell invented an improvement in the apparatus for the transmission and reproduction of articulate speech, in which magneto-electric currents were superposed upon a voltaic circuit, and actuated an iron diaphragm attached to a soft iron magnet.

During the same year, Dolbear conceived the idea of substituting permanent magnets in place of the electro-magnets and battery previously employed, and of using the same instrument for both sending and receiving, instead of employing instruments of different construction, as had been previously done.

In 1877, Edison applied to the telephone the discovery made by himself a few years before, of the variation of resistance which carbon and certain other semi-conductors undergo when subjected to a change of pressure. By this means he not only succeeded in varying the strength of the battery current in unison with the rise an fall of the vocal utterances, but, at the same time, also obtained louder articulation.

Thus, the last link in the long chain has been completed, in the production of that marvellous invention, the speaking telephone. In that machine the speaker speaks to a plate of solid iron, and the voice of the speaker is converted into electricity. That voice, operating upon the electro-magnet of Prof. Henry generates a current of electricity, which, flowing over the line to the distant station, excites magnetism in a corresponding magnet, and sets in vibration a plate of iron similar to that to which the speaker speaks, and that plate speaks to the listener. It speaks with the tone of the human voice, and so that, if three people are speaking at one end, three distinct tones are heard at the other.

That is the crowning achievement of the electro-magnetic telegraph.

The author follows up the introduction of the subject, which we have freely used above, by exhaustive exemplification of the various points involved, including full information as to the speaking telephone, Bell's telephonic researches, history of the production of galvanic music, Gray's telephonic researches, Edison's telephonic researches, electro-harmonic telegraphy, Dolbear's telephonic researches, improvements of Channing, Blake, and others, the talking phonograph, quadruplex telegraphy, electric call bells, and the electric light; and altogether the work is an exhaustive and able exposition of the whole subject.

According to Mr. Prescott's views of the matter, Professor Bell's claims, as originator of the speaking telephone, are of no very high order.

COLLECTING BUTTERFLIES AND MOTHS.

"Collecting Butterflies and Moths: being Directions for Capturing, Killing, and Preserving Lepidoptera and their Larvæ." Illustrated. (Reprinted, with additions, from "Practical Taxidermy." By Montagu Browne, Author of "Practical Taxidermy." London: "The Bazaar" Office, 170, Strand, W.C.

This small shilling work will be very useful to all collectors of butterflies and moths. Moreover it will be found to contain much instruction for those who wish to become acquainted with the branch of entomology therein treated of.

HOLMES' BOTANICAL NOTE-BOOK.

"Holmes' Botanical Note-Book; or, Practical Guide to a Knowledge of Botany." By E. M. Holmes, F.L.S., Curator of the Museum of the Pharmaceutical Society of Great Britain, late Lecturer on Botany at Westminster Hospital. London: Christy & Co. 1878.

Botanical text-books, note-books, and introductions to botany are by no means rare; yet the book before us may be considered a model work of its kind, for it is portable and can be carried in a coat-pocket without inconvenience, fully one half of the entire bulk being occupied with blank schedules. Further it is cheap. Step by step, in plain language, it leads us through all the points necessary to be mastered to fit a student, not only to pass his examination satisfactorily, but also to prepare him for the use of more advanced books. Three plates represent the scarlet geranium, daisy, dandelion, and narcissus, each part being properly described and made plain by a line leading directly to it. In the explanation of the diagrams the plants so referred to are very clearly printed in black capitals, and their description given in a few words. Indeed, this part of the work will enable any one who takes any notice of plants to quickly obtain a general knowledge of botany. A few simple instructions are given for describing a plant in the schedules. The glossary occupies the central portion of the book, and is, in fact, one of its chief features, being arranged, as above stated, in proper sequence to agree with other parts; thus we find root, stem, leaf, &c., and under each head is detailed the characters, shapes, or forms assumed by each organ, and a few familiar plants are quoted in each instance as illustrating the meaning of the term. The "Floral Calendar," or list of plants flowering in each month throughout the year, will be found very useful, arranged as the plants are under their distinct natural orders. The book is abundantly interleaved, and a large number of blank schedules are bound up with it; and we are further reminded that these can be had separately from the publishers in books containing one hundred each for the sum of one shilling.

ROCK BLASTING.

"Rock Blasting: a Practical Treatise on the Means employed in Blasting Rocks for Industrial Purposes. By G. G. ANDRE, F.G.S. (Spon.)

THIS work which may be regarded as an American one, is of interest not to the miner only, but to the civil and military engineer. It fully discusses the whole subject under its three great divisions of the drill, the charge, and firing the shot. The first purely mechanical in interest, the other two involving chemical and physical questions of great scientific interest.

Mr. André, however, though very descriptive on hand-tools, and entirely admitting the great advantages of machine-borers, describes only one form of them; whilst as to firing machines good descriptions, with figures, are given of the several exploders used in this country and abroad.

Practical remarks as to explosives, and many valuable facts are given, amongst which the following are worthy of notice:—

"If dynamite be much handled out of the cartridges, it causes violent headaches; and the same effect is produced by being in a close room in which there is dynamite in the unfrozen state. Dynamite possesses one quality which places it at a disadvantage with respect to other explosives, namely, that of freezing at a comparatively high temperature. At about 40° F. the nitro-glycerine solidifies, and the dynamite becomes chalky in appearance. In this state it is exploded with difficulty, and consequently it has to be thawed before being used. This may be safely done with hot water; performed in any other way the operation is dangerous." We hope this last warning will not be disregarded, and that miners will learn to avoid their reckless habits of handling this terrible power.

The plates which illustrate the work are admirable, as are also the woodcuts, and the whole work cannot be too highly commended, whether in regard to scientific elucidation or practical instruction.

THE BRITISH ASSOCIATION.

AT the remaining sittings of the Association, subsequent to those reported in the SCIENTIFIC REVIEW for September, 1878, the transactions were as follows:—

AUGUST 19TH.

SECTION A.—MATHEMATICAL AND PHYSICAL SCIENCE.

In this section Professor Perry presided. A paper was read by Mr. W. Ladd, on Edmund's phonoscope, an instrument for producing figures and light from vibration of sound. It consists essentially of three parts, an induction coil, an interrupter, and rotary vacuum tube. The action of the instrument is as follows. Sounds from the voice or other sources produce vibrations on the diaphragm on the interpreter, which, being in the primary circuit of the induction coil, induce at each interruption a circuit in the secondary coil similar to the action of a contact breaker or rheotome. Therefore, each vibration is made visible as a flash in the vacuum tube, the tube revolving all the time at a constant speed. The flashes produce a symmeterical figure. The number of spokes or radii are according to the number of vibrations in the interrupter during the revolution of a tube, the number of vibrations being varied to any extent. According to the sounds produced the figures in the revolving tube will be varied. The same sounds always produce the same figures, providing the revolutions be constant. In case of rythmical interruptions being produced in a given sound, as in a trill, most beautiful effects are noticeable, owing to the omission of certain radii in regular positions in the figures. The uses of this instrument are the rendering visible of sounds and showing the vibrations respired in their production, and is a mode of confirming sound. The phonoscope is the invention of Mr. Edmunds, jun., partner in the firm of Ladd and Co., London. The description of the invention excited much interest.

Among the papers which have been read in this section was one "On the Stanhope Demonstrator, or Logical Machine," by the Rev. Robert Harley, F.R.S., Vice-Master of Mill-hill School. Towards the close of the last century a logical instrument was constructed by Charles, third Earl Stanhope. The present earl found the instrument and some fragmentary papers on logic among the relics of his scientific ancestor, and at the suggestion of Dr. Spottiswoode, placed them in the hands of Mr. Harley, who has made a careful study of them. Earl Stanhope (born 1753, died 1816) is known to science chiefly by his printing press, microscopic lens, arithmetical machine, monochord, and steamboat. But of his logical speculations, which occupied his thoughts for thirty years, and of his curious mechanical contrivance for working logical problems, called by him the demonstrator, nothing has been known. Mr. Harley did not attempt to give a complete or systematic exposition of the earl's logical system, but he brought out those points which serve to illustrate the demonstrator as a method of mechanically performing logical inference. He noticed that Stanhope anticipated George Bentham, Sir W. Hamilton, George Boole, and others in his quantification of the predicate, and notably De Morgan's rule for the numerically definite syllogism. Stanhope states the rule as applicable to all syllogistic reasoning, and he constructed his demonstrator for the mechanical working of the rule. Some amusement was created in the section by Mr. Harley working by means of the instrument De Morgan's example—"Most men in a certain company wear coats. Most men in a certain company wear waistcoats. Therefore, some men in the same company wear both coats and waistcoats." Other examples were given. The instrument does not seem equal to very difficult and complicated questions, nor nearly so powerful as Professor Jevons's logical machine, but to Earl Stanhope belongs the honour of being the first, so far as is known, to attempt the performance of logical inference by mechanical means. The contrivances of earlier logicians, more particularly the circles of Euler, probably prepared the way, but Earl Stanhope did undoubtedly take a very important step in advance when he conceived and constructed his demonstrator.

Dr. Spottiswoode, the President of the Association, expressed his satisfaction that the instrument and papers had found so lucid an expositor as Mr. Harley; and he was sure that his neighbour in Kent, Earl Stanhope, would be gratified to learn that the matter had received the attention of the Association, and had excited so much interest.

SECTION B.—CHEMICAL SCIENCE.

In this section the papers were of a character not allowing of epitomising.

SECTION C.—GEOLOGY.

In this section, which was presided over by Mr. Evans, Mr. J. Nolan, M.R.I.A., read a paper on the metamorphic and intrusion rocks in Tyrone. They belonged, he said, to the three great classes of schist and gneiss, hornblende and pyroænic, being nearly porphyry granite. Some of the latter in his opinion were intrusive, and the intrusion must have occurred during the old red sandstone period, which was a new fact in Irish geology.

Mr. W. Withens read a paper on the Cerous Magaceros, and exhibited specimens of the skulls and horns of some which he had found at the bottom of lakes. He believed that they had been buried and that the skulls were afterwards broken, us they appeared, by masses of ice or boulders falling upon them. He argued that there was first a cold period, then a milder one, and then another cold period. In the discussion which followed, Dr. Leith Adams remarked that there was no evidence that the Irish elk was contemporaneous with man. They found with the elk some specimens of the grisly bear, but no domestic animals. In England, on the other hand, there was evidence that the elk was contemporaneous with man.

Mr. Pengelly said there were plenty of lions and hyenas found in the Kent Caverns, but there was no evidence of any tigers having existed in Britain.

Mr. Tedman examined some of the specimens exhibited by Mr. Withens. He disputed the inference that they afforded any evidence of a glacial period.

BIOLOGY.

Professor Huxley presided in this section.

Professor Flowers read a paper on the methods and results of measuring the capacity of crania. He pointed out the difficulty and importance of arriving at the simplest and most accurate method, and that no value could be attached to the system of weighing ths brain, because it differed in weight according to the health of the person and other circumstances. The only solution of the difficulty was by ascertaining the capacity of the cavity in which the brain was contained, and in the case of extinct animals it would be desirable to ascertain this. Two methods had been proposed—that by M. Broca, and the English method of Mr. Busk. He had adopted the latter, with some modifications. It consisted of filling the cavity of the skull with moistened seed well shaken and pressed into it, and then placed in the measurer with glass sides, in which it is well shaken and pressed. The figures on the side indicate the capacity. He gave comparisons of the different sizes of skulls representing different nations, and remarked as a curious fact that in the Museum of the College of Surgeons there is no skull of an Irishman.

The President assumed that perhaps the fact could be accounted for by the Irish skulls being all broken. (Laughter.)

An interesting paper was read by Professor Daniel Wilson, F.R.S.E., of the Toronto University, containing illustrations of the evolution of new varieties of men. In the mingling of different races in America, so complex and varied, all subjected to the influences of climate and social habits, and all mingling in blood in a greater or less degree with the native red races, hybridity had resulted on a great scale. The process had already been developed sufficiently long to afford important indications of the evolutions of permanent hybrid varieties. A specimen is to be seen among the half-breeds in Manitoba, as it were, in the process of evolution; while sheltered within the remote Arctic regions man can be studied among the Esquimaux in conditions closely analogous to those which are ascribed to a post-pliocene, if not to a pre-glacial period. In the abrupt collision of the civilised races of Europe with the American aborigines, it had always been taken for granted that the latter were doomed to inevitable extinction, and that the land would be peopled with the purely civilised races of the world. There is no question, however, that from an early date there has been inter-marriages between Europeans and the American races. A growing feeling is manifesting itself in the United States and Canada that the Indian population is not doomed to extinction, and that a much larger amount of healthy intermarrying and consequent absorption has existed than unobserving critics had any conception of, and that the native Indian element is a factor in the population of the new world destined to exercise an enduring influence on the ethnical character of the Euro-American races.

Mr. A. L. Lewis read a paper on the evils arising from the use of historical national names as scientific terms. The propositions which he endeavoured to establish were—1. That there were at the first population of Europe certain primitive races, of which three are particularly described. 2. That these races are so mixed that at the present day the representatives of them appear not only in most European nations, but in the same families and among children of the same parents. 3. That, notwithstanding this mixture and the effects which it must permanently have, racial characters display an astonishing permanence. 4. That this mixture, being so slow in its effects, and yet having become so general, has probably been at work for a very great length of time—so great that the peoples to whom the earliest history introduces us were probably nearly as much mixed as those of the present day. 5. That it is desirable to discontinue the use of the political names of those peoples as ethnic names, and to employ others based on the physical characteristics of the individual. 6. That while physical characteristics are the only basis for a true division into races, yet in the practical application of this division the influence upon individuals of different races of a community of language, custom, history, or tradition must not be lost sight of, although these things do not prove community of race, but only the contact at some time or other of the races to whom they are now common.

The President said he doubted whether any deliberate system of misnomer had worked more mischief in this world than the preposterous tattle about the national qualities of the Celt and Saxon. He took the liberty a few years ago—and got into hot water for doing so—of trying to awaken popular attention to what were the facts in reference to the use of these terms and what mischief was being done by using them in so inappropriate a manner as they are continually used by political writers. His conclusions were certainly in accordance with those of Mr. Lewis. He did not believe that race had any appreciable influence on either the social or political condition of the present day. His impression was that if the south-eastern parts of England—say, the county of Kent—had been subjected to the same conditions 400 or 500 years ago as Connemara or Galway, they would expect the results to be as nearly as possible the same; and a most curious result of ethnological study was that the parts of Ireland which were supposed to exhibit in the most marked manner those attributes sometimes complementary, sometimes not complementary, of what is called the Celtic character were exactly those in which it could be demonstrably proved that a Norman or English element was predominant.

SECTION E.—GEOGRAPHY.

Sir Wyville Thomson presided.

Captain Burton read a paper on the Land of Midian.

The President, in moving a vote of thanks to Captain Burton, referred to the assistance given by Mrs. Burton to her husband in his travels and researches. The vote was passed with acclamation.

The Rev. Mr. Holland recognised as Sinaitic some inscriptions, photographs of which had just been placed in his hands by Captain Burton.

Mr. Hamilton said he had found the name of Captain Burton, whom he regarded as the greatest of all living travellers—(applause)—extolled in every portion of the earth. With reference to the mineral wealth of Midian, he thought there must be some regions there where the Arabs get their most magnificent gold ornaments.

Captain Burton said his conviction was that gold working is continued to the present day in Midian. He had found an old man in Suez who, in his youth, used to wash gold there.

The Rev. Mr. Holland said the Sinaitic peninsula was full of the traditions of the passage of the children of Israel, but as there had been monks there for hundreds of years, it was probable that the traditions had been introduced by the monks. It would be interesting to know if such traditions existed in Midian, on the other side of the Gulf.

Captain Burton said he had found no trace whatever of the passage of the Israelites, but great traces of Moses having lived there. In that part of Midian where Moses is supposed to have married the daughter of Jethro, they showed his praying-place at the top of a hill. The tradition of Moses can be traced back to the remotest days of Mahomedanism.

Consul Hutchinson welcomed Captain Burton as an Irishman back to Dublin. His name was known in Africa long before that of Speke, or Stanley, or Cameron, or other great men. Mr. Hutchinson did not speak to disparage their merits, but his principle was *Palmam qui meruit ferat*, and he regarded Captain Burton as our greatest discoverer. He might mention that Captain Burton was the only one who had ever entered the shrine of the Prophet Mahomet at Mecca. (Applause.)

Captain Burton briefly acknowledged the vote of thanks.

Dr. Leared read an interesting account of a journey to Fez and Mequinez.

Dr. Phené read a paper on the acquisition of Cyprus, and observations on some islands in the Levant with reference to recent discoveries.

SECTION F.—ECONOMIC SCIENCE AND STATISTICS.

Dr. Ingram presided in this section.

The principal interest was centered in a paper by Professor Hancock on the Deportation of Irish paupers from England. He advocated a uniform law of settlement for the three kingdoms. A lively debate ensued, the inhumanity of the present practice being denounced on the one hand, and on the other the Scotch members present objecting to any encouragement being given to imprudence by enabling persons to squander their money in drink.

SECTION G.—MECHANICAL SCIENCE.

Mr. Easton, C.E., presided.

Mr. Preece read a paper on improvements in telegraphy. Its object was to vindicate the telegraph department from the reproach sometimes cast upon it of having originated no improvement since it became connected with the State. He gave a minute account of the various apparatus which have been in use for receiving messages by sight or sound—the former being indispensable when fast telegraphing is required, and the latter best adapted for ordinary use—and enumerated the various modifications which have been made in them in order to render the transmission of messages more rapid and efficient, and obviate the special difficulties which arise from the cloudy and humid atmosphere of England. By a recent improvement the rate of speed between England and Ireland has been increased 100 per cent. Some of the inventions tried years ago fell into disuse because they were premature, but there is now an increased demand owing to the lowering of the scale. Gintl in 1853 invented a mode of sending two messages in opposite directions on the same line. In 1872 Mr. J. B. Stearne in America removed a defect in it, and there were now nearly 200 circuits in England worked on the duplex system. In 1855 it was discovered that two messages could be sent in the same direction, and hence duplex telegraphy was introduced. The two plans being combined formed quadruplex telegraphy. It was first used by the Western Union Telegraph Company in America in 1876, and is now applied there to 60 circuit telephone currents (verbal telegraphy), which are minute currents following each other with great rapidity on to superposed or ordinary working currents without interfering with their action as ordinary telegraph apparatus. Mr. Cromwell Varley utilised the principle in 1870 by patenting what may be called harmonic telegraphy; but it remained for Mr. Elisha Gray, of Chicago, to work it out practically. Other systems for increasing the capacity of the wires have been devised on the Continent. The most valuable of all are the Wheatstone automatic and the quadruplex, but each has its disadvantages—principally the employment of a more highly trained staff. Now, these systems of fast speed and multiplex telegraphy have grown up in England under the fostering care of the Post Office since the transfer of the telegraphs to the State, and England stands prominent as the home of the inventor. She can boast of her Wheatstone, Cooke, Bain, Thomson, Clarke, Varley, Fuller, and others; and Europe can boast its Gintl, Siemens, Frischen, and Mayer; and America has her Morse, Hughes, Stearns, Edison, and Gray. The Americans have freely adopted the English system of pneumatic telegraphy and methods of testing. They are introducing on some lines automatic telegraphy, modified by Messrs. Little and Edison, and are trying our superior batteries. Hence, while we have not been slow to avail ourselves of their advance, they have equally availed themselves of our progress. Invention has not left the shores of England, but the telegraph department stands in the front rank. It remains to say a few words for the Post Office. The system of news wires is unique of its kind. Forty-seven news circuits and 22 special wires were made up every day. News is transmitted direct from London to every town where there is a daily paper. This is done by the automatic principle (mechanical transmission). Half a million words are frequently sent in one night from London. When Lord Beaconsfield gave his address in the House of Lords on the results of the Berlin Congress, 526,250 words were transmitted from the central station. There is not a branch of the service that has not been improved. New batteries, new insulators, improved wires, the most perfect relays and multiplex apparatus have all found their way into the Post Office service. Of the 8000 miles of additional wire put up, more than half is for private use; so that the daily average of messages is even greater than has been stated. No one is heard to complain but some disappointed inventor. Practical inventions rarely emanate from without, but the great majority of patents were taken out by persons who do not possess them at all. The fact remains that telegraphy is more highly developed in England than in any other country.

At the conclusion of Mr. Preece's paper the Chairman remarked that Mr. Preece had doubted whether Mr. Graham Bell desired to be classed among English or American inventors.

Mr. Bell said he wished to be placed in the category to which he rightly belonged—the inventors on the British isles. He did not wish to question the statement of Mr. Preece that invention had not fled from the shores of the British Empire, but he wished to call attention to one or two points. Mr. Preece had said that Government control had not tended to hinder invention in this country. His personal experience of Government control had been this. In the beginning of the year 1874 he invented in America a system of multiple telegraphy, by which sixteen or twenty messages might be sent simultaneously on a single wire, and this was submitted by him to the Telegraph Department of the British Government. In reply to his request for an investigation he received a printed paper, such as probably was sent out to every inventor who applied to the Postal Department. It stated that the Post Office Department would take into consideration the invention submitted at the expense of the inventor, and that in the event of the improvement in telegraphy being thought worthy to be adopted by the Government, the question of remuneration would be left entirely to the Postmaster-General. It was that reply that induced him to bring forward his invention in America. He brought his system of multiple telegraphy before the telegraph world in America, and the outcome had been the electric telephone. He should be the last man to say that Government control was not necessary in this country for the sending of telegraphic messages for public use. Still, he believed Government control to be destruction of invention.

Mr. Sanger, as an official of the Postal Telegraph Department, bore testimony to the great increase in the use of the telegraph by the public since it had passed into the hands of the Government. At one time the maximum speed between London and Dublin was 20 words per minute. Now it was 120, and during one of the nights of the present meeting of the British Association, 60,000 words had been sent from Dublin to the various towns of the United Kingdom.

Mr. Saunders, of the Central News Agency, said he had found a telephone company in Boston, in the United States, but there was nothing of the kind in this country, and he should like to have an explanation of that. As for Government control he thought it was advantageous. As far as the supply of news to the public was concerned, the Government did not collect news itself, but it allowed collectors of news to send what news they pleased. In the case of the old companies which collected news themselves the effect was injurious. When the failure of Overend, Gurney, and Co. occurred, for instance, the Intelligence Department, considering that sort of news dangerous, declined to send it on.

Dr. Cameron, M.P., said in his mind Mr. Preece's paper resolved itself into the question of sixpenny telegrams. Why had we not got sixpenny telegrams? (Hear, hear.) He was a member of the Select Committee of the House of Commons on telegraphs last year, and before the committee evidence was given to his mind which to his mind clearly established that the wires were very much underworked. They found clerks in some large towns transmitting 50 or 60 messages a day who could transmit 20 to 30 per hour, so that the amount of work done did not represent more than three or four hours out of the 24, the wires being idle for the remainder of the time. The Postal Telegraph Department was suffering a loss, and the question before the committee was whether they should increase the price of telegrams, the effect of which would be to curtail the work of the clerks, or to cut down the price, and thus bring in a larger measure of traffic. The House of Commons did not adopt this policy. If anything was proved by the paper of Mr. Preece, it was that the department had got into thorough working order, that it was capable of doing everything that it would be capable of doing, and therefore he again asked, Why had we not got 6d. telegrams? We were in advance of other countries in the matter of news supply, but not in the matter of private telegrams. In France and Belgium a half-franc rate existed at present, and even before the transfer of the telegraphs to the British Government a 6d. rate existed in London. It had been suggested that pneumatic tubes should be extensively laid down in large towns. There was nothing to prevent them from radiating from one common centre, so that written messages might be sent at once by those tubes without the work which was necessary in the case of transmission by electricity, of copying and re-copying at the ends of the telegraph wire. Mr. Symington had been carrying on a precisely similar system in Edinburgh for some years past with the A B C telegraph instrument, enabling persons, if they desired it, to communicate directly with each other; but when Mr. Symington worked at his perfectly novel idea he was threatened by the Post Office, and he was actually afraid to come up to London to give evidence before the Parliamentary Committee on that point.

Mr. Preece, replying, said the letter sent to Mr. Bell in answer to his request for an investigation of the multiple telegraph invention, was the stereotyped answer given to every inventor—that the Department would give it attention, and if it proved successful would remunerate the inventor fairly. The same thing happened nearly every day—certainly every week. One of his own special duties—and it was a very unpleasant one—was to investigate these propositions of inventors, and in 999 cases of 1000 they were absurd, and in all his experience he could only call to mind one active enterprising gentleman who complained that he was scurvily treated. The fact that the telegraph was more extended in America than here was not the fault of the British Government, but was due to the existence of greater private enterprise in America. The reason why the use of the telephone was not extended in England was the outrageous terms that were asked for its use. It was only within the last few weeks that it had fallen into the hands of English commercial gentlemen, and he was sure that it would soon be used for private purposes in England as in America. For public purposes the Post Office had found it was not applicable, after giving it a very fair trial. As to 6d. telegrams, as Dr. Cameron had failed to induce the House of Commons to force the Post Office to introduce them, he was not likely to be able to do so without the help of Parliament. He had no doubt the day of 6d. telegrams would come, but under present circumstances the proposition was impracticable. They had at present only 4,000 miles of wire to deal with, and 500,000 messages per week, but if 6d. telegrams were introduced, the number would probably go up to 1,500,000. What Dr. Cameron referred to as the idle time of the wires could not be utilised, because it was taken up with the sending of Press news. They had at present a great burden to bear in being obliged to send addresses in messages free. On the Continent where half-franc messages existed, the number of words was much less than here. If the number of words were reduced here, it would be quite possible to introduce the 6d. system. As to the pneumatic tubes they had found that they would involve a great expenditure in the maintenance of engines and offices. This Post Office Department was conducted on purely commercial principles, and they would not adopt anything unless they could show that it would pay.

A vote of thanks was given to Mr. Preece.

MEETING OF THE GENERAL COMMITTEE.

The General Committee met at three o'clock, under the presidency, first of Mr. Spottiswoode, and then of Lord O'Hagan, one of the vice-presidents. A deputation attended to support the invitation of Sheffield to receive the Association next year. It was stated that in January last the inhabitants were asked to subscribe to a guarantee fund for £2,000, and already they had subscribed £3,300, and they would subsubscribe 5,000 or £6,000. The surrounding towns supported the invitation, and there was ample accommodation in Sheffield for the Association. The Mayor of Swansea handed in an invitation for the Association to meet at that place in 1880. It was unanimously resolved to accept both invitations.

Professor Huxley moved that Dr. George Ulman, F.R.S., be appointed President-elect for the Sheffield meeting. He was one of the most distinguished cultivators of biological science in these islands, and held a position of great importance both in Ireland and at the other side of the Channel, having last filled the chair of Regius Professor of Natural History in Edinburgh. Since he had retired from that position he had become resident in London, where he continued his researches, and his contributions to the branch of science which he had pursued unremittingly for the last thirty-five years had been of the greatest possible value to any one engaged in the same pursuits.

The resolution was seconded by Professor Flowers.

Lord O'Hagan expressed his great pleasure in putting it, and stated that he had known Mr. Ulman since his boyhood, for they had both been pupils in the Belfast Academic Institution.

On the motion of Mr. Evans, President of the Geological Section, the officers were appointed for the next meeting:—Vice-Presidents, the Duke of Devonshire, Earl Fitzwilliam, Earl Wharncliffe, Professor Huxley, Professor Odling, F.R.S., General Simpson, Mr. H. C. Sorby, F.R.S., Mr. F. H. Moss, local treasurer; Mr. H. Stephens, Captain Douglas Galton. Mr. J. C. Sclater was re-elected general scrutineer of the Association. Mr. J. E. H. Gordon was elected assistant secretary in place of Mr. Griffith, who has retired, and in passing the resolution the highest testimony was given to the great services rendered by Mr. Griffith during the many years he had been connected with the Association. Lord O'Hagan added that he had known Mr. Griffith a number of years, and was sure that everyone regretted his loss.

AUGUST 20TH.

SECTION A.—MATHEMATICAL AND PHYSICAL SCIENCE.

Mr. James Glaisher read the report of the Committee on Luminous Meteors.

Lord Rosse gave an account of a new equatorial mounting for a 3ft. reflector recently erected at Parsonstown. He said he did not intend to enter into the general theory of telescopes, or the various necessary things to their proper construction, but merely to give a verbal explanation of the peculiarities of the equatorial mounting recently erected at Parsonstown, and show the points on which it differed from the ordinary type of mounting, and its relative advantages and disadvantages. All the optical arrangements of the telescope are the same, and the instrument differs only in the mounting. The wooden tube has been replaced by an iron one constructed from designs by Mr. Binden Stoney. The description was illustrated by a model constructed on a scale of one inch to the foot. The leading peculiarities of this invention consist in the points of reversal being at the east and west, instead of the north and south, and the motions are effected by means of screws, so that the instrument cannot run away with one and get broken against the gallery if the wind be high. The tube is square, which is also an unusual feature, and the clock is connected to the gallery by means of a strap. Lord Rosse also exhibited a model of a mounting for a telescope constructed by Mr. Grubb for the Melbourne Government—the only one larger than that lately erected at Parsonstown. He pointed out the disadvantages in connection with the point of reversal in this and other telescopes being at the south, and this was just where the observations were most frequent and most important. He also explained the construction of the gallery, which was quite unique, and expressed his indebtedness to Mr. Binden Stoney and to Mr. Strike. A cordial vote of thanks was passed to Lord Rosse.

Professor Henry Hennessy read a paper on the Limits of Hypotheses regarding the Physical Properties of the Matter of the Interior of the Earth.

Professor Henry Hessey also read a paper on the climate of the British Islands.

Mr. Richard Anderson, F.R.S., read a paper on lightning conductors and accidents by lightning, which gave a rather startling warning against the neglect of precautions for the protection of public buildings and private houses.

SECTION C.—GEOLOGY.

Professor Hull read a paper on the progress of the Geological Survey of Ireland.

The President (Mr. Evans) congratulated the chief on the progress that had been made.

Dr. Sterry Hunt observed that in the State of Pennsylvania these reports and memoirs were printed and stereotyped, and then offered to the public for the mere cost. The memoir on the table priced at 9s. would be sold there for 2s.

Mr. Tiddeman said he would be sorry if any one should think that the Survey was responsible. (Hear.) It was disagreeable to them to find that their labour was almost entirely thrown away by the high prices of the publications when they came out, in the miserable manner in which they were produced, and which would almost disgrace a fifth-rate publishing firm. (Applause.)

Mr. Tiddeman read a report of the Committee on Erratic Blocks, in the course of which it was stated that it appeared from geological observations that Ireland at a very early period must have "thrown stones" at England, though in no instance had England returned the compliment. (Laughter.) A Cornish geologist, who had had unparalleled opportunities of observing sections of drifts, said that the raised breakers of the Cornish coast contain flints and pieces of basalt.

Professor Dawkins said, in reference to the conclusion that in ancient times Ireland had been throwing stones at England, that the same thing was observable in Scotland; that blocks of stone from the Hebrides were to be found on the mainland of Scotland, while none of the Scotch blocks were to be found in the Hebrides.

Dr. J. Sterry Hunt, F.R.S., read a paper "On the Origin and Succession of the Crystalline Rocks of North America."

Dr. Henry Hinks read a paper on some new pre-Cambrian areas in Wales, which led to a warm discussion.

The Abbé Renard, addressing the section in French, which was translated by the President, observed that he had examined the Ardennes of France and Belgium, the rocks of which, like those of a similar character in England and Wales, appeared to him to be pre-Cambrian. Only the upper beds of the Ardennes were fossiliferous. There were no signs of contact with intrusive or eruptive rocks, and no vitreous appearance. He regarded the rocks as originally sedimentary, and deposited under conditions with which we are at present unacquainted.

Professor Hull said they were all gratified at the presence of Professor S. Hunt, to whom they were much indebted for the light he had thrown on the formation by hydrothermal processes of those veins which he called exotic and on the origin of those enormous masses of crystalline material of Canada and North-Western America. Geologists, however, should beware of the conclusions which he appeared to have drawn from his rapid survey of the crystalline rocks of the North-West of Ireland, Scotland, and Wales. He (Professor Hull) entirely dissented from the view expressed by Dr. Hinks of the correlation of the crystalline rocks of the north-western portions of the British islands with the ancient crystalline rocks of Canada belonging to the Laurentian and Huronian periods. He thought if anything was established it was the succession of the crystalline rocks of the Highlands. He protested against amateur geologists ("Oh, oh"), no matter how able and distinguished, making rapid traverses of such a country as North Wales, and issuing *data* with regard to its structure, and then putting forward views so entirely different from those arrived at by trained members of the Geological Survey, who had spent many years in the careful step-by-step delineation of the country.

The President remarked that there was no feeling between the Geological Survey and the amateurs, unless that the latter were naturally anxious to find something which the former had not found and to make the most of it.

Professor Hughes thought that Dr. S. Hunt and Dr. Hinks had been doing a great deal of good.

The Rev. W. S. Symonds said that his 30 years' observations as an amateur, not only in these countries, but all over Europe and America, led him to agree with Dr. Hunt.

Mr. J. Thomson stated that in the Hebrides he had found exactly the same structures of rocks as those which Dr. Hunt had described as occurring in America.

Professor Hull said that he had been unfortunate in using the word "amateur," for no one had a higher respect for the labours of qualified amateur geologists.

SECTION D.—BIOLOGY.

Lord Talbot de Malahide presided.

M. Henry Martin, the French historian, read a paper on the "Ancient Races of Ireland, and the utility in relation to the Ethnography of early Europe of studying the traditions concerning them."

A vote of thanks to M. Martin was passed.

Captain R. F. Burton read a paper entitled "Notes on the Tribes of Midian."

SECTION E.—GEOGRAPHY.

Captain Verney R.N., presided in this section.

Dr. Rae delivered an essay on the best route to attain a high northern latitude, or the Pole itself. He reviewed the progress and results of previous expeditions, referring particularly to the Nares expedition.

Dr. Moss read a paper on the geographical significance of North Sea polar ice.

Captain Dyer, R.N., turned the thoughts of the sections into a less frigid current by referring to his early recollections of Greenwich Hospital, in which he was born, concluding with a stave of a song, which he sang in the tones of a true British sailor, to the wonder and amusement of all present.

In reply to Mr. E. Nugent, Dr. Moss said at latitude 82 36 inside a tent the temperature was 80°.

The President conveyed the thanks of the section both to Dr. Rae and Dr. Moss.

Mr. J. Stevenson read a paper on the opening up of the East African lake district.

Sir C. Wyville Thomson read a paper on the official report of the Challenger Expedition. He said that, as two years had elapsed since the return of the expedition he might reasonably be expected to give some account of the progress made in classifying the observations which were made in different departments. The voyage of the Challenger, he observed, had been undertaken for a very definite purpose—the determination of the physical conditions of the ocean. The period of three years and a half occupied by the cruise round the world was too short even to draw the first outline sketch of general deep-sea conditions. While the ship was at sea their time was entirely depoted to registering observations, and cataloguing and labelling, and storing specimens. Owing to the great liberality of the Government in supplying abundantly all the necessary materials and appliances both for procuring specimens and preserving and storing them, an enormous collection had been sent home from time to time in wonderfully good condition. He proposed to the Government that it should for the present be placed in University of Edinburgh, and that their attention should be confined for the first year to the preparation of an outline of the general report, to securing the safety of the collection and arranging it in zoological sequence, and that for that purpose the services of the scientific staff on board should be retained. He proposed that gentlemen of recognised authority in different departments should be engaged to undertake the description of the group, and that they be illustrated; that the most complete series possible of all species of which there were duplicated should be sent to the British Museum; and that duplicates should be afterwards distributed in museums at home and abroad, according to a scheme to be sanctioned by the Government. He had not allowed any personal considerations or considerations of nationality to interfere, his only object being to prepare the best possible report. From what he saw at present he calculated that the report, which was a very difficult one, would extend to from 14 to 16 quarto volumes of 500 or 600 pages. The whole will be illustrated by about 1200 plates, with many woodcuts and photographs. The map of the first volume was nearly completed, also the charts or ship's course, and the section showing the natural distribution of ocean temperature. The volume in course of preparation will be illustrated by photographs and woodcuts. The second volume will consist chiefly of tables, and will include a report on the magnetic observations made during the voyage, drawn up under the superintendence of the Hydrographer to the Navy, and a detailed report on the meteorology prepared by Captain Tezard. Most of this volume was already in print, and he had there a copy of the chart in proof and on proof paper, which would give them some idea of the appearance of the book. Another volume would contain the discussion of the nature of the bottom, the composition of its contained gases and a number of other general matters, and the remainder of the book would be occupied by a series of memoirs by different authors on the various groups of animals which constituted the deep sea fauna. A large number of these monographs were in progress, and they had there the first of a series of beautiful plates by Mr. Holdich, illustrating mostly the pelagic genera. These plates represented several forms of a remarkable group of shigopods, to which they had given the name of challengerida, as they seemed to have hitherto escaped observation. There were probably from twenty to thirty specific forms of these. Next, they had a rapidly growing pile of plates illustrating a splendid memoir on the Radiolari, by Professor Hatchel. Any one acquainted with Hatchel's classical work, "Die Radiolariem," would have some idea of what might be expected of that memoir. The next series of plates represented the deep sea corals, and were being prepared under the direction of Mr. Moseley; and the next series, also by Mr. Moseley, represented a most remarkable little series of coralloid forms of the Hydrogor, which Mr. Moseley had named the Hydrocoroltmal, and on their strictness and relations Mr. Moseley's careful work during the voyage and since their return had thrown quite an unexpected light. The ordinary hydroids were in the hands of Professor Allman, and they had already secured for different departments of the work the services of nearly all the available British artists. Professor Hatchel would describe the few deep water medusæ which were brought home, and which he found of the highest interest. The Peliatozo would be described by himself. About twenty plates were cut stone, illustrating the structure of the stalked crinoids. Professor Alex. Cigussis was going on rapidly with the Echiniden, and his memoir, exquisitely illustrated, would be among those first published. Mr. Lyman was working at the Opherxides, which he said were almost new and he expected Mr. Sheil, of Upsala, to come over to examine the Holotheridæ which he was going to describe, under the general superintendence of Professor Lowe.

The address was received with loud applause, and a vote of thanks was passed to Sir Wyville Thomson.

SECTION F.—ECONOMIC SCIENCE AND STATISTICS.

Professor Ingram, S.F.T.C.D., presided.

Mr. H. L. Jephson read a paper on "The desirability of simultaneous and identical legislation for England and Ireland."

Dr. Hancock read a paper "On the Importance of raising Ireland to the level of England and Ireland in the matters of Industrial Schools and Compulsory Education."

Mr. Hancock read a curious paper by Professor Jevons "On the Periodicity of Crises and its Physical Explanation." The paper showed that during the last 160 years there had been sixteen great commercial crises at intervals of about ten years, and concluded by stating that the fact of periodicity of commercial crises was so strong that it could not be doubted, and the question of a physical cause was only a matter of speculation.

Mr. A. Twill protested against such a thing being accepted as an explanation. He attributed the crises to over-speculation, and Lord Justice Turton accounted for it by the Limited Liability Act.

Mr. J. T. Pim observed that Mr. Twill could not deny that trade had been very much influenced by a good or bad harvest, and he was not sufficient of a physicist to say that spots on the sun had nothing to do with a bad harvest.

Dr. Hancock remarked that General Larcom, having observed these ten years' crises, and also that spots on the sun coincided with them, had come to the same conclusion as Professor Jevons with regard to the cause of distress in Ireland.

A special meeting of the Board of Trinity College was held, and the degree of LL.D. was conferred *Honoris Causa* on the following distinguished members of the British Association:—W. Spottiswoode, H. J. Stephen-Smith, W. Janssen, M. Simpson, H. E. Roscoe, A. W. Williamson, J. Evans, Sir J. Lubbock, Sir J. D. Hooker, W. H. Flower, T. H. Huxley, Sir W. C. T. Thompson, and J. Thompson.

SECTION B.—CHEMICAL SCIENCE.

A paper read in this section by Mr. W. Chandler Roberts, F.R.S., attracted much attention. The subject was the detection by means of the microphone of sounds which accompany the diffusion of gases through a thin septum. He stated that the passage of gas by diffusion was undoubtedly due to molecular motion, and he showed the great importance of studying facts which appeared to bear on molecular movement. Without committing himself to the view that sounds rendered evident by the telephone when nitrogen was diffused through a septum were wholly due to molecular movement, he explained points which appeared to favour that view.

Professor Emerson Reynolds observed that having been allowed by Mr. Rogers to make observations, he heard a distinct rushing of sound while the apparatus was surrounded with hydrogen. On removing the jar of hydrogen he heard the distinct rush again, but it might have been caused by the inrush of air.

Mr. Fletcher, while hoping that the sound might be due to molecular movement, thought there were other sources to which it might be traced.

Mr. Roberts said he anticipated that it might be due to the change of volume inside the box, and he was particularly careful to establish the relations with the air through the tube.

Dr. Willis suggested that as the whole apparatus was surrounded with the jar of hydrogen gas the difference might have been in the material of the microphone itself. It was made of gas coke and the pores no doubt were full of air. An interchange of the air with the hydrogen would occur, and it may have been this action which was heard.

Mr. Spottiswoode said he was struck by one point in the discussion that processes which were long regarded as continuous proved, under closer examination, to be intermittent.

Dr. Emerson Reynolds described the process by which indigo blue was produced artificially by Beyer.

The Chairman (Professor Gladstone) remarked that the process was too expensive to be of practical use.

SECTION C.—GEOLOGY.

Dr. Sterry Hunt read a paper on the "Geological relations of the Atmosphere," in which he stated his agreement with the views of Sir W. R. Grove, that our atmosphere is not terrestrial, but cosmical, being a universal medium diffused throughout all space, but condensed around the various centres of attraction in amounts proportioned to their mass and temperature, the waters of oceans themselves belonging to this universal atmosphere. Such being the case, any change in the atmospheric envelope of any globe, whether by the absorption or the disengagement of any gas or vapour, would, by the laws of diffusion and static equilibrium, be felt everywhere throughout the universe, and the fixation of carbon at the surface of our planet would not only bring in a supply of this gas from the world beyond, but by reducing the total amount of it in the universal atmosphere diminish the barometric pressure on the surface of our own and of all other worlds. He combatted the various hypotheses that had been put forward to account for the climatic changes of the earth's surface in past ages that geology had demonstrated.

Dr. Pengelly observed that this paper should be discussed before all the sections, for it contained physical, mathematical, biological, and geological considerations. He did not think the time had come for solving the problem it involved, but there reemed to be a tendency to accept the idea of a cosmic atmosphere, though smaller than that of the earth. He was not prepared to say how far astronomers had discovered any atmosphere in the moon. When she went through the heavens and came near a star, the star went behind her and its light was lost to sight for some time. If the moon had an atmosphere, the light of the star would be refracted and the period of concealment would be much less.

Mr. M. Williams said this subject had been very fully discussed in 1822 by Dr. Wollaston. The theoretical atmosphere of the moon was equal to about one-eighth of an inch of mercury—just enough to puzzle observers, but certainly insufficient to produce the effect which Dr. Pengelly had pointed out with reference to the refraction of a star's light when passing behind the moon. They should remember that the limb of the moon was produced by the summits of the lunar mountains looking along their edges, and if there was any atmosphere it would be a small amount in the valleys. There was, indeed, a small amount of atmosphere indicated by what had the appearance of hoar frost. He was inclined to believe from later investigations that the primary condition of bodies was gaseous, and that their solidity and fluidity were the result of compression.

Professor Boyd Dawkins said that apart from any astronomical or chemical views, looking at the question from a geological point, the conclusions entirely coincided with everything he knew.

Professor Hughes inquired at what time the necessity arose for bringing matter from the outer world to the surface of the globe. Nature was full of compensations, and when anything was in excess found some way of putting it right.

Dr. Sterry Hunt replied that the process began when decomposition commenced on the earth. Carbonic acid was a life-giving gas, without which no plant or animal could live.

Professor W. King read a paper "On the Age of the Crystalline Rocks of the County of Donegal."

Professor J. P. O'Reilly read a paper "On the Correlation of Lines of Direction on the Globe, and particularly of Coast Lines."

The Rev. M. H. Close read a paper "Concerning the Extent of Geological Time," in which he combated the physical arguments for the inconvenient restriction of the geological period.

The Rev. Professor Haughton, M.D., F.R.S., read a paper "On the Earth's Axis."

(*To be continued.*)

THE INVENTORS' INSTITUTE.

ESTABLISHED 1st MAY, 1862.

FORTNIGHTLY MEETINGS, DURING SESSION,
HELD (NOVEMBER TO MAY INCLUSIVE) AT

4, ST. MARTIN'S PLACE, TRAFALGAR SQUARE, W.C.

PAST PRESIDENT—SIR DAVID BREWSTER, K.H., LL.D., F.R.S., &c., from the Establishment of the INVENTORS' INSTITUTE till his decease, February, 1868.

PAST PRESIDENT—LORD RICHARD GROSVENOR, M.P., &c., from February, 1868, till May, 1871.

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